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BULK FLOTATION OF CARIBOU ORE IN THE CONTINUOUS PROCESS DEVELOPMENT UNIT

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by

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SUMMARY

Caribou ore was subjected to bulk flotation in the continuous processing development unit using the same technique developed for Brunswick Mining and Smelting Corp. ore. The test runs were conducted at an ore feed rate of 24 kg/h and grind of 80% minus 500 mesh. Projected recoveries for a target grade of 30% zinc in the bulk concentrate and feed averaging 7.30% zinc, 2.82% lead, 0.32% copper and 70.3 g/t silver were 90.0%, 68.1%, 58.5% and 55.6% for these metals respectively. These recoveries are judged to be unsatisfactorily low and are attributed to the incomplete liberation of the base metal sulphides in the ore. The comparable recoveries obtained for bulk flotation of Brunswick Mining and Smelting Corp. ore were 96.0%, 82.1%, 78.1% and 76.5%.

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CPDU Test Reports 18

Batch Test "B" - Flotation Test Report

Batch Test "B" - Metallurgical Balance

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INTRODUCTION

BACKGROUND

In 1975 CANMET initiated a research project whose objective was to increase metal recoveries from the complex and fine-grained massive sulphide ores of New Brunswick. Because conventional concentration using selective flotation techniques offered little scope for achieving higher recoveries, a new scheme was proposed. This was to produce a bulk flotation concentrate from which the metals would be extracted using the hydrometallurgical route. Because concentrate grade requirements are less stringent, a higher recovery can be obtained for bulk flotation. Also all metals are available for recovery by the subsequent extraction process, whereas with separate, selectively-floated concentrates contaminating metals such as lead and copper in the zinc concentrate are considered as lost as they are not paid for by the smelter.

The first stage in the implementation of the research project was a comprehensive bench-scale investigation to develop bulk flotation techniques for Brunswick Mining and Smelting Corp. ore (1). This was followed by the production of a quantity of bulk concentrate on a continuous scale in the 50 kg/h continuous process development unit (CPDU) (2). Heath Steele ore was then investigated using similar bulk flotation techniques. With the bulk flotation investigation of the Caribou ore, the final stage of the research project on the New Brunswick sulphide ores has been completed.

HISTORY OF CARIBOU ORE DEPOSIT

The Caribou massive sulphide deposit is located 48 km west of Bathurst, New Brunswick and was discover ⌟ in 1955. Anaconda (Canada) Co. Ltd. has the majority ownership of the property with a minority held by Cominco Ltd. Despite ore reserves of 49.4 million tons grading 4.48% zinc, 1.7% lead, 0.47% copper, 58 g/t silver and 1.4 g/t gold the property has not been put into production because of problems in concentrating the ore.

During the past 25 years many investigations have been carried out by various laboratories in attempts to develop a satisfactory concentration scheme for the Caribou ore. The senior author contributed to these efforts in 1965-1967 (3) and again in 1974-1975 (4). Practically all of the testwork was directed toward the production of separate copper, lead and zinc concentrates by selective flotation.

OBJECT OF INVESTIGATION

The object of the investigation was to determine whether the Caribou ore was amenable to the same bulk flotation techniques that had been successfully employed for the Brunswick Mining and Smelting Corp. and Heath-Steele ores.

ORE SAMPLE

A 6-ton ore sample consisting solely of large lumps free of fines and contained in 12 steel drums was received in October 1981. Analysis as calculated by averaging the feed to the CPDU test runs was as follows:

Table 1 - Ore sample analysis

Zinc	7.30%
Lead	2.82%
Copper	0.32%
Silver	70.3 g/t
Gold	2.06 g/t

MINERALOGY

The mineralogy of the Caribou ore deposit has been studied extensively (5). Therefore there was no need to submit this particular ore sample for further mineralogical examination. As is the case with the other two major massive sulphide deposits in New Brunswick extremely fine grinding would be required to liberate the base metal sulphides from the pyrite.

OUTLINE OF INVESTIGATION

SCOPE

A total of 17 bulk flotation test runs was conducted in the CPDU during the period May 17 - June 24, 1982 at a feed rate of 24 kg/h. Duration of the first 10 test runs ranged from 5 to 6 1/2 h with a set of samples taken during the last 45 minutes of the test run (samples cut every 15 minutes) when it was assumed that the conditions had stabilized. This first phase of the CPDU campaign was devoted to establishing conditions to give the required

grind of 80-85% minus 500 mesh and optimizing reagent feed rates and pH's. When this was accomplished, the length of the test runs was increased to 13-14 h with two sets of samples taken - the first set about half way through the test run and the second set at the end of the test run.

CRUSHING

The lump ore was first crushed to minus 25 mm. To ensure thorough mixing, individual ore lumps from each barrel were fed to the crusher in rotation. The minus 25 mm ore was then reduced to minus 1.65 mm (10 mesh) as required by the CPDU.

GRINDING

Single-stage, open-circuit grinding was employed. The grinding mill used was a 16-in. x 32-in. Denver loaded with 194.6 kg of steel rods.

FLOTATION

Previous experience with the flotation of the complex New Brunswick sulphide ores has indicated that they have similar flotation characteristics. Therefore, it was not deemed necessary to carry out a comprehensive batch-scale investigation of the Caribou ore prior to the CPDU campaign. Batch testing was limited to a few tests carried out for comparison purposes.

For the bulk flotation of Brunswick Mining and Smelting Corp. and Heath-Steele ores it was the practice to employ the selective sphalerite collector Z-200 in conjunction with isopropyl xanthate and Aerofloat 242. This collector which was made by the Dow Chemical Co. is no longer available. Therefore, for the bulk flotation of the Caribou ore the equivalent American Cyanamid Co. collector Aerofloat 211 was substituted.

In previous CPDU investigations of New Brunswick sulphide ores bulk flotation was carried out using the 8-litre capacity No. 5 Denver flotation machines. To obtain optimum recoveries it was found necessary to employ 8 of these machines in series. At a feed rate of 24 kg/h and flotation feed density of 40% solids, pulp residence time in 8 of these cells is 93 minutes. This is an exceedingly long residence time when compared to industrial practice which for a similar application would be to use 16 to 20 flotation cells in series with a total residence time of about 20 minutes. For the bulk flotation of the Caribou ore therefore it was decided to use smaller capacity

flotation roughers. Available were 4-4 litre flotation cells and 3-2.5 litre flotation cells both of CANMET design. This combination connected in series gives a total capacity of 23.5 litres and a residence time of 26 minutes.

ANALYSIS OF PRODUCTS

Samples were filtered, dried and prepared for analysis on an overtime basis following the completion of the run. They were then analyzed by XRF (X-ray fluorescence) the following morning. Also, as noted some of the CPDU test products were analyzed by AAS (atomic absorption spectrophotometry) to provide calibration standards for XRF and to confirm XRF analyses.

CONCURRENT INVESTIGATIONS

The availability of freshly-produced CPDU products was taken advantage of to carry out two concurrent investigations which are the subjects of separate reports:

(1) the testing of a new 1-litre flotation machine design; and
(2) separation of the bulk concentrate into copper, lead and zinc concentrates.

DISCUSSION AND EVALUATION OF RESULTS

RANGE OF RESULTS OBTAINED

The range of results obtained for bulk flotation of Caribou ore in the CPDU is given in Table 2. For zinc, the data are also presented graphically in the form of a grade-recovery curve in Fig. 1. The flowsheet, details of test procedure, product analyses and metallurgical balances for these tests are given in Appendix A.

As can be seen from Fig. 1 five points can be joined to produce a smooth zinc grade-recovery curve. Also, two points from batch "B" (test details in Appendix A) lie on the curve which enhances its validity. Four points lie outside the curve - two of these viz., 12-2 and 9 are so far off that they can be considered to be erratic values.

Table 2 - Range of results obtained for CPDU bulk flotation of Caribou ore

Run No.	Product	Wt %	Analysis* Zn %	Pb %	Cu %	Ag ppm	Au ppm	Distribution Zn	Pb	Cu	Ag	Au
7		17.26	35.52	9.79	0.95	-	-	82.0	59.3	52.4	-	-
8		20.22	31.37	9.26	0.81	-	-	88.8	64.5	53.3	-	-
9		25.02	26.19	7.43	0.79	-	-	91.1	64.6	62.2	-	-
11-2	Bulk	19.50	32.19	7.80	0.73	147	2.80	90.1	58.9	48.2	45.5	26.3
12-2	cleaner	19.90	29.90	7.86	0.78	156	2.61	83.1	58.9	50.5	44.7	23.9
13-2	conc	27.19	25.62	7.23	0.73	158	3.46	93.0	70.1	61.6	57.0	42.5
15-2		22.11	31.36	8.77	0.87	180	2.96	91.0	68.8	59.2	57.7	32.4
16-2		20.06	32.80	9.39	0.98	185	2.80	86.5	67.6	57.7	53.0	30.1
17		23.57	27.79	7.88	0.92	172	3.04	92.2	68.8	62.5	57.4	35.3
7		82.74	1.63	1.40	0.18	-	-	18.0	40.7	47.6	-	-
8		79.78	1.00	1.29	0.18	-	-	11.2	35.5	46.7	-	-
9		74.98	0.85	1.36	0.16	-	-	8.9	35.4	37.8	-	-
11-2	Final	80.50	0.86	1.32	0.19	42.9	1.90	9.9	41.1	51.8	54.5	73.7
12-2	tail	80.10	1.51	1.36	0.19	48.0	2.06	16.9	41.1	49.5	55.3	76.1
13-2		72.81	0.72	1.15	0.17	44.6	1.75	7.0	29.9	38.4	43.0	57.5
15-2		77.89	0.88	1.13	0.17	39.4	1.75	9.0	31.2	40.8	42.3	67.6
16-2		79.94	1.29	1.13	0.18	41.2	1.63	13.5	32.4	42.3	47.0	69.9
17		76.43	0.72	1.10	0.17	39.4	1.72	7.8	31.2	37.5	42.6	64.7
7			7.48	2.85	0.31	-	-					
8			7.14	2.90	0.31	-	-					
9			7.19	2.88	0.32	-	-					
11-2	Feed		6.97	2.58	0.30	63.4	2.08					
12-2	(calc'd)		7.16	2.65	0.31	69.5	2.17					
13-2			7.49	2.80	0.32	75.4	2.22					
15-2			7.62	2.82	0.32	72.5	2.02					
16-2			7.61	2.79	0.34	70.0	1.86					
17			7.10	2.70	0.35	70.7	2.03					

* Zn, Pb and Cu by AAS

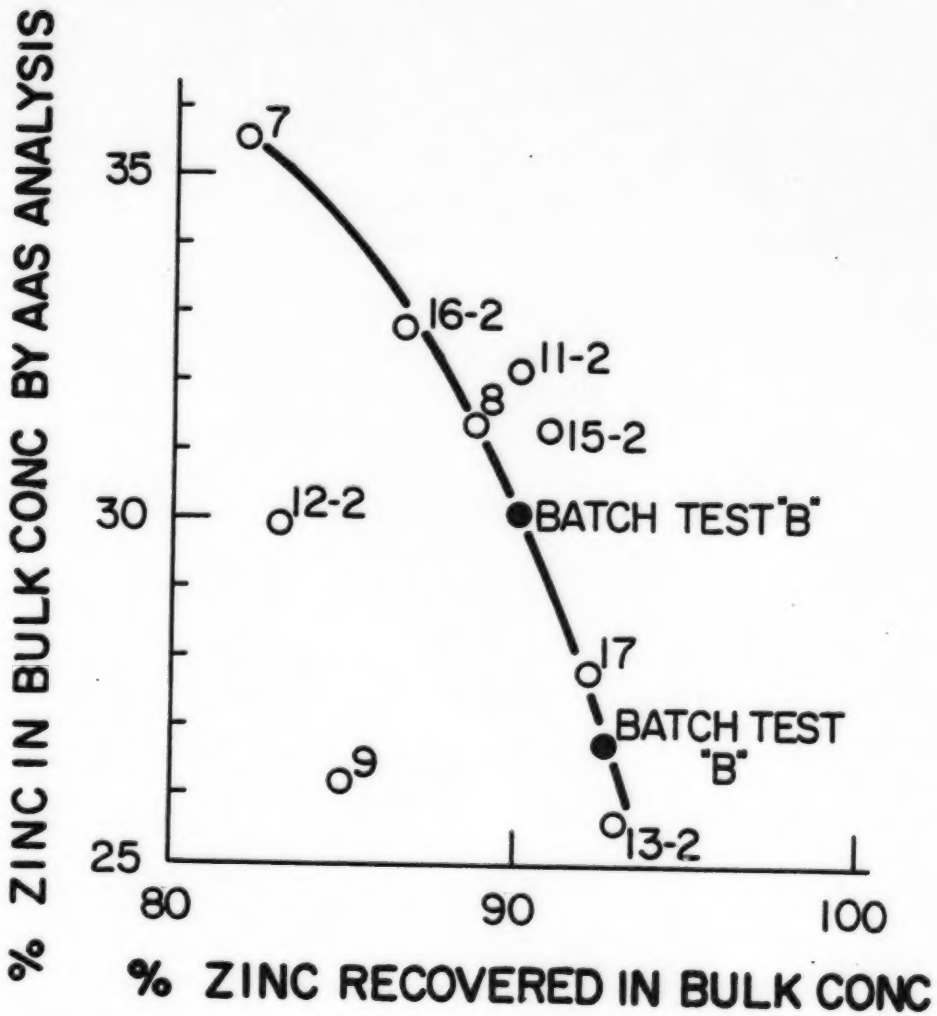

Fig. 1 - Zinc grade-recovery curve for bulk flotation of Caribou ore

PROJECTED BULK FLOTATION RESULTS

From the curve in Fig. 1 zinc recovery for a target grade of 30% zinc in the bulk concentrate is 90%. For this zinc grade-recovery combination a reasonable assumption for lead, copper, silver and gold losses sustained in the tailings based on a perusal of data in Table 2 is 1.15%, 0.17%, 40 ppm and 1.75 ppm. Using the preceding data and average CPDU heads of 7.30% zinc, 2.82% lead, 0.32% copper, 70.3 ppm silver and 2.06 ppm gold the projected bulk flotation results for a continuous large-scale operation have been calculated and are given in Table 3.

COMPARISON OF RESULTS FOR BULK FLOTATION OF NEW BRUNSWICK ORES

In Table 4 one of the best set of bulk flotation results achieved for the Caribou ore (Test Run No. 15-2) is compared with the best results obtained for Brunwick Mining and Smelting Corp. and Heath-Steele ores.

As can be seen from the comparison the Caribou ore did not respond to bulk flotation as well as the other two ores. Although a bulk concentrate with a target grade of 30% zinc could readily be produced, it was accompanied by low lead, copper and silver recoveries. There was no increase in the recoveries of these metals even when bulk concentrate grade was lowered to about 25% zinc (Test Run No. 13-2, Table 2), but there was a reduction in zinc in the tailing to give a 2% increase in zinc recovery. It is presumed that, as was the case with previous investigations of Caribou ores, the high tailing losses are due to incomplete liberation of the base metal sulphides.

EFFECT OF CIRCULATING LOAD

To determine the effect, if any, of the circulating load it was calculated for all CPDU test runs in which one stage of cleaning was employed. The circulating load consists of the bulk cleaner tailing and the bulk scavenger concentrate both of which were recycled to rougher flotation feed. Because a complete set of AAS analyses were not available, XRF analyses were used in the calculations which are given in Appendix B.

In Table 5 bulk flotation results for zinc are matched with the calculated circulating load of zinc units. The increase in zinc units in the flotation feed due to the circulating load is expressed as a multiplier of the zinc units in the new feed. Thus a figure of 2X indicates that with the inclusion of the circulating load the resultant flotation feed contains twice the zinc units contained in the new feed.

Table 3 - Projected results for bulk flotation of Caribou ore

	Wt	Analysis					Distribution				
Product	%	Zn %	Pb %	Cu %	Ag ppm	Au ppm	Zn	Pb	Cu	Ag	Au
Bulk cl conc	21.90	30.00	8.8	0.85	177	2.89	90.0	68.1	58.5	55.6	33.6
Final tail	78.10	0.93	1.15	0.17	40	1.75	10.0	31.9	41.5	44.4	66.4
Feed	100.00	7.30	2.82	0.32	70.3	2.06	100.0	100.0	100.0	100.0	100.0

Table 4 - Comparison of results for CPDU bulk flotation of New Brunswick ores

Product	Wt %	Analysis					Distribution %				
		Zn %	Pb %	Cu %	Ag ppm	Au ppm	Zn	Pb	Cu	Ag	Au
Caribou CPDU Test Run No. 15-2, Grind 96% - 400 m											
Bulk cl conc	22.11	31.36	8.77	0.87	180.0	2.96	91.0	68.8	59.2	57.7	32.4
Final tail	77.89	0.88	1.13	0.17	39.4	1.75	9.0	31.2	40.8	42.3	67.6
Feed (calc'd)	100.00	7.62	2.82	0.32	72.5	2.02	100.0	100.0	100.0	100.0	100.0
Brunswick Mining and Smelting Corp - CPDU Test Run No. C-6-1, Grind 94% - 400 m											
Bulk cl conc	27.01	30.24	9.42	1.06	291.0	-	96.0	82.1	78.1	76.5	-
Final tail	72.99	0.47	0.76	0.11	33.0	-	4.0	17.9	21.9	23.5	-
Feed (calc'd)	100.00	8.51	3.10	0.37	102.7	-	100.0	100.0	100.0	100.0	-
Heath-Steele CPDU Test Run No. 5, Grind 89% - 400 m											
Bulk cl conc	14.19	28.09	6.35	2.97	246.0	-	93.4	74.5	77.8	66.0	-
Final tail	85.81	0.33	0.36	0.14	21.0	-	6.6	25.5	22.2	34.0	-
Feed (calc'd)	100.00	4.27	1.21	0.54	53.0	-	100.0	100.0	100.0	100.0	-

Table 5 - Comparison of bulk flotation results versus circulating load

CPDU	Bulk Flotation Results					Calc'd Circulating Load			New Feed + CL			Increase in Flotation Feed Due to CL	
Test	Bulk Conc		Tail	Feed (Calc'd)	Zinc	Wt	Zinc		Wt	Zinc			
Run No.	Wt %	% Zn	% Zn	% Zn	Recovery, %	Units	%	Units	Units	%	Units	Weight	Zinc Units
7	17.90	34.57	1.27	7.23	85.6	44.31	16.58	734.5	144.31	10.10	1457.6	1.44X	2.02X
8	20.99	30.78	0.76	7.06	91.5	54.18	16.63	901.2	154.18	10.43	1607.4	1.54X	2.28X
11-1	20.28	33.81	0.87	7.55	90.8	45.74	17.41	796.4	145.74	10.65	1551.5	1.46X	2.05X
11-2	20.78	31.61	0.67	7.10	92.5	97.81	16.64	1627.2	197.81	11.82	2337.2	1.98X	3.29X
12-1	25.02	25.63	0.71	6.95	92.3	60.19	10.03	603.6	160.19	8.10	1298.1	1.60X	1.87X
12-2	22.02	29.62	1.01	7.31	89.2	58.97	14.55	858.2	158.97	10.00	1589.2	1.59X	2.17X
13-1	29.40	21.85	0.49	6.77	94.9	30.10	6.86	206.5	130.10	6.79	883.5	1.30X	1.31X
13-2	27.53	25.01	0.60	7.32	94.1	42.58	8.65	368.3	142.58	7.72	1100.3	1.43X	1.50X
15-1	22.40	28.06	1.23	7.24	86.8	59.72	16.10	961.7	159.72	10.55	1685.7	1.60X	2.33X
15-2	23.05	30.77	0.76	7.68	92.4	65.39	14.81	968.5	165.39	10.50	1736.3	1.65X	2.26X
16-1	21.82	29.80	1.02	7.29	89.1	54.46	18.13	987.3	154.46	11.11	1716.7	1.54X	2.35X
16-2	21.59	32.10	1.02	7.73	89.7	38.77	17.90	693.9	138.77	10.57	1466.9	1.39X	1.90X
17-1	23.39	28.29	0.63	7.10	93.2	94.26	11.54	1087.5	194.26	9.25	1797.8	1.94X	2.53X

From the figures in Table 5 it can be seen that the 3 tests in which the lowest grade of bulk concentrate were produced, viz, 12-1, 13-1, and 13-2 also had the lowest circulating load of zinc units. Other than this, no correlation could be established between circulating load and bulk floation results.

LEAD RECOVERY

In Table 6 lead tailing losses are compared to zinc results and to other test variables which could have an effect on lead recovery in the bulk concentrate. Normally it would be expected that the lead losses in the tailing would parallel those of zinc but there did not appear to be any significant degree of correlation between the two. The closest correlation was between high pH in the cleaner and high lead tailings. Except for one test run (15-2) higher lead tailings losses resulted when a high pH (10.2 to 10.6) was employed in cleaning. In the earlier test runs (7 and 8) the high lead tailings could be attributed to the lower level of collector addition.

CONCLUSIONS

The Caribou ore does not respond to bulk flotation as well as the Brunswick Mining and Smelting Corp. or Heath-Steele ores. Satisfactory recoveries could not be achieved despite the very fine grind employed (80 to 85% -500 mesh) and the high amounts of collector added (375 g/t). The best recoveries obtained for the target grade of bulk concentrate (30% Zn) were 91.0, 68.8, 59.2 and 57.7% for Zn, Pb, Cu and Ag respectively. The comparable recovery figures for bulk flotation of Brunswick Mining and Smelting Corp. ore were 96.0, 82.1, 78.1 and 76.5%.

The low recoveries can be attributed to incomplete liberation of the base metal sulphides in the ore. It does not appear to be either practical or economical to grind the ore to the extent necessary to liberate the significant portion of the valuable sulphides which occur as extremely fine grains.

Table 6 - Effect of various test variables on lead recovery in bulk concentrate

Run No.	Loss in* Tailings Zn %	Loss in* Tailings Pb %	Pb Rec %	Bulk Conc* Grade % Zn	pH Ro	pH Cl	Collector, g/t 343	Collector, g/t Total	CL of Pb Units
7	1.27	1.41	58.8	34.57	10.4	9.7	135	285	2.24X
8	0.76	1.32	64.2	30.78	10.1	9.6	160	310	2.36X
9	0.71	1.21	69.8	25.14	11.6	-	170	325	1.73X
11-1	0.87	1.39	62.5	33.81	11.0	10.2	220	355	2.24X
11-2	0.67	1.43	59.6	31.61	11.3	10.5	220	355	3.55X
12-1	0.71	1.13	69.5	25.63	10.5	9.6	220	395	2.18X
12-2	1.01	1.43	61.3	29.62	10.7	9.6	220	395	2.30X
13-1	0.49	1.04	72.9	21.85	11.2	9.9	220	380	1.58X
13-2	0.66	1.16	71.7	25.01	10.8	9.9	220	380	1.77X
15-1	1.23	1.35	65.5	28.06	11.2	10.6	220	380	2.12X
15-2	0.76	1.15	69.6	30.77	11.2	10.6	220	380	2.46X
16-1	1.02	1.28	66.2	29.80	11.1	10.5	220	380	2.21X
16-2	1.02	1.18	69.1	32.10	11.1	9.8	220	380	1.92X
17	0.63	1.19	67.2	28.29	10.8	9.6	220	375	2.95X

* XRF analyses

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APPENDIX A

CPDU AND BATCH TEST REPORTS

LIST OF ABBREVIATIONS

RM - rod mill
calc'd - calculated
cl - cleaner
conc - concentrate
ro - rougher
scav - scavenger
tail - tailing

Cyanamid of Canada reagents

343 - sodium isopropyl xanthate
AF 242 - aerofloat 242 - liquid dithiophosphate type collector
AF 211 - sodium diisopropyl dithiophosphate

Dow Chemical Co. reagent

DF 250 - Dowfroth 250, water soluble frother

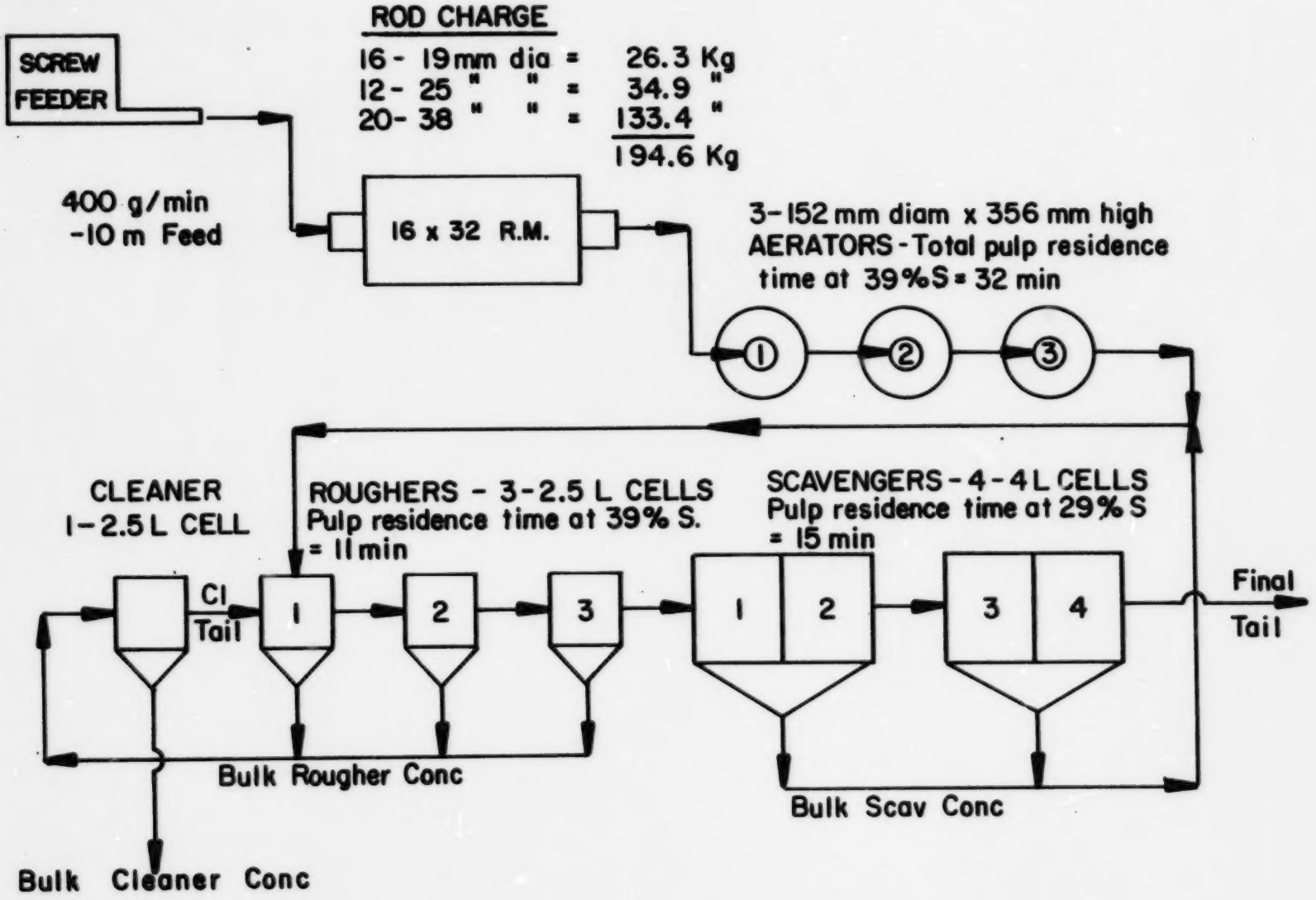

Fig. A-1 - CPDU flowsheet for bulk flotation of Caribou ore

CANMET
CONTINUOUS PROCESS DEVELOPMENT UNIT
TEST REPORT

Test Run No: 7	Feed rate: 24 kg/hr
Date: May 27, 1982	Time operated: 08:45-13:25
Ore: Caribou	Sampling period: 12:30 - 13:15

Remarks: Bulk flotation with one stage of cleaning as per flowsheet

AVERAGE CONDITIONS DURING SAMPLING PERIOD

Point of Addition	Reagents, g/t ore treated							% S	pH	Grind % -500 m
	Lime	$CuSO_4$	343	AF 242	AF 211	DF 250	HCl			
Rod mill	1000							70		76.2
Aerator 1	1200	1500								
Aerator 3			60	25	50	5				
Ro cell 1			50			6		39	10.4	
" " 2					25					
" " 3			25							
Scav cell 1					25	9				
" " 3					25					
Cleaner cell									9.7	
Total	2200	1500	135	25	125	20				

METALLURGICAL BALANCE

Product	Wt %	Analysis					Distribution, %				
		% Zn	% Pb	% Cu	g/t Ag	g/t Au	Zn	Pb	Cu	Ag	Au
Bulk cl conc	17.26	35.52	9.79	0.95			82.0	59.3	52.4		
Final tail	82.74	1.63	1.40	0.18			18.0	40.7	47.6		
Feed (calcd)	100.00	7.48	2.85	0.31			100.0	100.0	100.0		
Feed (assay)		7.48	3.07	0.32							
Bulk cl tail		22.48	8.45	0.81							
Bulk ro conc		29.09	9.05	0.89							
Bulk ro tail		4.80	3.28	0.34							
Bulk Scav conc		13.44	8.02	0.73							

CANMET
CONTINUOUS PROCESS DEVELOPMENT UNIT
TEST REPORT

Test Run No: 8	Feed rate: 24 kg/hr
Date: May 31, 1982	Time operated: 08:45 - 14:00
Ore: Caribou	Sampling period: 12:30 - 13:15

Remarks: Conditions similar to previous run but with an additional 25 g/t 343 fed to scavenger.

AVERAGE CONDITIONS DURING SAMPLING PERIOD

Point of Addition	Reagents, g/t ore treated							% S	pH	Grind % -500 m
	Lime	$CuSO_4$	343	AF 242	AF 211	DF 250	HCl			
Rod mill	1000							70		80.5
Aerator 1	1400	1500								
" " 3			60	25	50	5				
Ro cell 1			50			6		39	10.1	
" " 2					25					
" " 3			25							
Scav cell 1	700		25		25	6			9.8	
" " 3					25					
Cleaner cell								26	9.6	
Total	3100	1500	160	25	125	17				

METALLURGICAL BALANCE

Product	Wt %	Analysis					Distribution, %				
		% Zn	% Pb	% Cu	g/t Ag	g/t Au	Zn	Pb	Cu	Ag	Au
Bulk cl conc	20.22	31.37	9.26	0.81			88.8	64.5	53.3		
Final tail	79.78	1.00	1.29	0.18			11.2	35.5	46.7		
Feed (calcd)	100.00	7.14	2.90	0.31			100.0	100.0	100.0		
Feed (assay)		7.14	2.88	0.32							
Bulk cl tail		19.23	7.74	0.64							
Bulk ro conc		23.56	8.54	0.70							
Bulk ro tail		3.15	2.42	0.26							
Bulk Scav conc		10.73	7.02	0.54							

CANMET
CONTINUOUS PROCESS DEVELOPMENT UNIT
TEST REPORT

Test Run No: 9	Feed rate: 24 kg/hr
Date: June 1, 1982	Time operated: 09:00 - 14:30
Ore: Caribou	Sampling period: 13:00 - 13:45

Remarks: Cleaner cut out of circuit, Froth from rougher cells 1 and 2 taken as final conc - froth from rougher cell 3 and scavenger conc recirculated to rougher feed.

AVERAGE CONDITIONS DURING SAMPLING PERIOD

Point of Addition	Reagents, g/t ore treated							% S	pH	Grind % -500 m
	Lime	$CuSO_4$	343	AF 242	AF 211	DF 250	HCl			
Rod mill	1000							70		80.2
Aerator 1	1400	1500								
" " 3			60	25	50	5				
Ro Cell 1			55			6		39	11.6	
" " 2					30					
" " 3			30							
Scav cell 1	1000		25		25	5		35	10.9	
" " 3					25					
Total	3400	1500	170	25	130	16				

METALLURGICAL BALANCE

Product	Wt %	Analysis					Distribution, %				
		% Zn	% Pb	% Cu	g/t Ag	g/t Au	Zn	Pb	Cu	Ag	Au
Bulk conc	25.02	26.19	7.43	0.79			91.1	64.6	62.2		
Final tail	74.98	0.85	1.36	0.16			8.9	35.4	37.8		
Feed (calcd)	100.00	7.19	2.88	0.32			100.0	100.0	100.0		
Feed (assay)		7.19	3.08	0.33							
Ro conc, cell 3		22.49	7.95	0.80							
Ro tail cell 2		4.56	3.13	0.31							
" " " 3		3.06	2.78	0.28							
Scav conc		8.88	6.79	0.55							

CANMET
CONTINUOUS PROCESS DEVELOPMENT UNIT
TEST REPORT

Test Run No: 11 - 2	Feed rate: 24 kg/hr
Date: June 8, 1982	Time operated: 08:50 - 22:45
Ore: Caribou	Sampling period: 22:00 - 22:45
Remarks: Bulk cleaner cut back into circuit	

AVERAGE CONDITIONS DURING SAMPLING PERIOD

Point of Addition	Reagents, g/t ore treated							% S	pH	Grind % -500 m
	Lime	$CuSO_4$	343	AF 242	AF 211	DF 250	HCl			
Rod mill	1000							70		84.1
Aerator 1	1300	1500								
" " 3			90	25	50	5				
Ro cell 1			50			7		38	11.3	
" " 2					30					
" " 3			30							
Scav cell 1			50			7		29	10.6	
" " 3					30					
Cleaner cell									10.6	
Total	2300	1500	220	25	110	19				

METALLURGICAL BALANCE

Product	Wt %	Analysis					Distribution, %				
		% Zn	% Pb	% Cu	g/t Ag	g/t Au	Zn	Pb	Cu	Ag	Au
Bulk cl conc	19.50	32.19	7.80	0.73	147.0	2.80	90.1	58.9	48.2	45.5	26.3
Final tail	80.50	0.86	1.32	0.19	42.9	1.90	9.9	41.1	51.8	54.5	73.7
Feed (calcd)	100.00	6.97	2.58	0.30	63.0	2.08	100.0	100.0	100.0	100.0	100.0
Feed (assay)		6.97	2.81	0.31	72.0	2.06					

CANMET
CONTINUOUS PROCESS DEVELOPMENT UNIT
TEST REPORT

Test Run No: 12 - 2	Feed rate: 24 kg/hr
Date: June 10, 1982	Time operated: 09:00 - 22:15
Ore: Caribou	Sampling period: 21:30 - 22:15

Remarks: Changes from Run 11 - 2 :

(1) Fed additional AF 211 to scav cell 3

(2) Operated scavenger at lower PH

(3) Fed AF 242 to cleaner to float off a higher weight of conc

AVERAGE CONDITIONS DURING SAMPLING PERIOD

Point of Addition	Reagents, g/t ore treated							% S	pH	Grind % -500 m
	Lime	$CuSO_4$	343	AF 242	AF 211	DF 250	HCl			
Rod mill	1100							70		79.2
Aerator 1	1250	1500								
" " 3			90	25	50					
Ro cell 1			50			7		39	10.7	
" " 2					30					
" " 3			30							
Scav cell 1			50		30	6			9.8	
" " 3					30					
Cleaner cell				10				30	9.6	
Total	2350	1500	220	35	140	13				

METALLURGICAL BALANCE

Product	Wt %	Analysis % Zn	% Pb	% Cu	g/t Ag	g/t Au	Distribution, % Zn	Pb	Cu	Ag	Au
Bulk cl conc	19.90	29.90	7.86	0.78	156.0	2.61	83.1	58.9	50.5	44.7	23.9
Final tail	80.10	1.51	1.36	0.19	48.0	2.06	16.9	41.1	49.5	55.3	76.1
Feed (calcd)	100.00	7.16	2.65	0.31	69.5	2.17	100.0	100.0	100.0	100.0	100.0
Feed (assay)		7.16	2.81	0.31	73.7	2.09					

CANMET
CONTINUOUS PROCESS DEVELOPMENT UNIT
TEST REPORT

Test Run No: 13 - 2	Feed rate: 24 kg/hr
Date: June 15, 1982	Time operated: 09:00 - 22:30
Ore: Caribou	Sampling period: 21:45 - 22:30

Remarks: Cut AF 242 off cleaner

AVERAGE CONDITIONS DURING SAMPLING PERIOD

Point of Addition	Reagents, g/t ore treated							% S	pH	Grind % -500 m
	Lime	$CuSO_4$	343	AF 242	AF 211	DF 250	HCl			
Rod mill	1000							70		8.13
Aerator 1	1500	1500								
" " 3			90	25	50					
Ro cell 1			50			6		38	10.8	
" " 2					25					
" " 3			30							
Scav cell 1			50		30	7		27	10.0	
" " 3					30					
Cleaner cell									9.9	
Total	2500	1500	220	25	135	13				

METALLURGICAL BALANCE

Product	Wt %	Analysis					Distribution, %				
		% Zn	% Pb	% Cu	g/t Ag	g/t Au	Zn	Pb	Cu	Ag	Au
Bulk conc	27.19	25.62	7.23	0.73	158.0	3.46	93.0	70.1	61.6	57.0	42.5
Final tail	72.81	0.72	1.15	0.17	44.6	1.75	7.0	29.9	38.4	43.0	57.5
Feed (calcd)	100.00	7.49	2.80	0.32	75.4	2.22	100.0	100.0	100.0	100.0	100.0
Feed (assay)		7.49	2.79	0.34	72.9	1.90					

CANMET
CONTINUOUS PROCESS DEVELOPMENT UNIT
TEST REPORT

Test Run No: 15 - 2	Feed rate: 24 kg/hr
Date: June 22, 1982	Time operated: 09:00 - 22:30
Ore: Caribou	Sampling period: 21:45 - 22:30

Remarks: Repeat of Run 11 - high PH in roughers and cleaner

AVERAGE CONDITIONS DURING SAMPLING PERIOD

Point of Addition	Reagents, g/t ore treated							% S	pH	Grind % -500 m
	Lime	$CuSO_4$	343	AF 242	AF 211	DF 250	HCl			
Rod mill	1500							70		80.9
Aerator 1	1750	1500								
" " 3			90	25	50	5				
Ro cell 1			50			7		39	11.2	
" " 2					30					
" " 3			30							
Scav cell 1			50		25	7		31	10.6	
" " 3					30					
Cleaner cell									10.6	
Total	3250	1500	220	25	135	19				

METALLURGICAL BALANCE

Product	Wt %	Analysis					Distribution, %				
		% Zn	% Pb	% Cu	g/t Ag	g/t Au	Zn	Pb	Cu	Ag	Au
Bulk cl conc	22.11	31.36	8.77	0.87	180.0	2.96	91.0	68.8	59.2	57.5	32.4
Final tail	77.89	0.88	1.13	0.17	39.4	1.75	9.0	31.2	40.8	42.3	67.6
Feed (calcd)	100.00	7.62	2.82	0.32	72.5	2.02	100.0	100.0	100.0	100.0	100.0
Feed (assay)		7.62	2.80	0.34	73.7	1.90					
Bulk cl tail		17.60	4.53	0.62							
Bulk ro conc		22.83	6.11	0.69							

CANMET
CONTINUOUS PROCESS DEVELOPMENT UNIT
TEST REPORT

Test Run No: 16-2	Feed rate: 24 kg/hr
Date: June 23, 1982	Time operated: 09:00 - 22:00
Ore: Caribou	Sampling period: 21:15 - 22:00

Remarks: To try high pH in roughers and scavenger along with low pH in cleaner - 9.8 versus 10.6 in Run 15 - 2 (pH lowered with HCl)

AVERAGE CONDITIONS DURING SAMPLING PERIOD

Point of Addition	Reagents, g/t ore treated							% S	pH	Grind % -500 m
	Lime	$CuSO_4$	343	AF 242	AF 211	DF 250	HCl			
Rod mill	1600							70		80.0
Aerator 1	1750	1500								
" " 3			90	25	50	5				
Ro cell 1			50			7		37	11.1	
" " 2			30							
" " 3					30					
Scav cell 1			50		25	7		29	10.5	
" " 3					30					
Cleaner cell							112		9.8	
Total	3350	1500	220	25	135	19	112			

METALLURGICAL BALANCE

Product	Wt %	Analysis					Distribution, %				
		% Zn	% Pb	% Cu	g/t Ag	g/t Au	Zn	Pb	Cu	Ag	Au
Bulk cl conc	20.06	32.80	9.39	0.98	185.0	2.80	86.5	67.6	57.7	53.0	30.1
Final tail	79.94	1.29	1.13	0.18	41.2	1.63	13.5	32.4	42.3	47.0	69.9
Feed (calcd)	100.00	7.61	2.79	0.34	70.0	1.86	100.0	100.0	100.0	100.0	100.0
Feed (assay)		7.61	2.78	0.34	70.3	1.83					
Bulk cl tail		22.27	7.20	0.78							
Bulk ro conc		27.16	8.11	0.84							
Bulk ro tail		3.01	2.23	0.28							
Bulk scav conc		10.92	6.79	0.74							

CANMET
CONTINUOUS PROCESS DEVELOPMENT UNIT
TEST REPORT

Test Run No: 17	Feed rate: 24 kg/hr
Date: June 24, 1982	Time operated: 09:00 - 17:15
Ore: Caribou	Sampling period: 16:00 - 17:15

Remarks: Repeat of Run 16 - 2

AVERAGE CONDITIONS DURING SAMPLING PERIOD

Point of Addition	Reagents, g/t ore treated							% S	pH	Grind % -500 m
	Lime	$CuSO_4$	343	AF 242	AF 211	DF 250	HCl			
Rod mill	1500							70		8.12
Aerator 1	1750	1500								
" " 3			90	25	50	5				
Ro cell 1			50			7		38	10.8	
" " 2					30					
" " 3			30							
Scav cell 1			50		25	7		29	10.1	
" " 3					25					
Cleaner cell							112		9.6	
Total	3250	1500	220	25	130	19	112			

METALLURGICAL BALANCE

Product	Wt %	Analysis					Distribution, %				
		% Zn	% Pb	% Cu	g/t Ag	g/t Au	Zn	Pb	Cu	Ag	Au
Bulk of conc	23.57	27.79	7.88	0.92	172.0	3.04	92.2	68.8	62.5	57.4	35.3
Final tail	76.43	0.72	1.10	0.17	39.4	1.72	7.8	31.2	37.5	42.6	64.7
Feed (calcd)	100.00	7.10	2.70	0.35	70.7	2.03	100.0	100.0	100.0	100.0	100.0
Feed (assay)		7.10	2.90	0.35	72.0	2.04					
Bulk cl tail		16.05	6.72	0.67							
Bulk ro conc		19.19	7.08	0.77							
Bulk ro tail		2.59	2.64	0.28							
Bulk Scav conc		10.92	6.79	0.74							

FLOTATION TEST REPORT

TEST NO. "B"	SAMPLE: Caribou	DATE: May 19, 1982
OBJECT OF TEST: Bulk flotation		CHARGE: 2000 g
		TESTED BY: G.W.L

OPERATION	Time min	% Solids	pH	Unit used	Reagents, Grams									
					Line	NaCN	343	$CuSO_4$	MIBC					
Grinding	90	65	10.5	7x14 RM	4.0	0.25	0.10							
Aeration	10			Aerator				2.0						
Bulk rougher		35		1000 g-cell										
Stages 1	½		11.0		0.9		0.10		0.02					
" 2	½						0.025							
" 3	½						0.025							
" 4	1		10.2				0.025							
Bulk Scavenger	2		10.0						0.02					
Bulk Cleaners														
No.1	2		9.6	500 g-cell										
No.2	2		9.4	250 g-cell										
No.3	2		9.0	250 g-cell										

REMARKS: 88 % minus 500 mesh grind

METALLURGICAL BALANCE

Test No. "B" | SAMPLE: Caribou | Date: May 19, 1982

	PRODUCT	WT %	ANALYSIS %						DISTRIBUTION %				
			Zn	Pb	Cu				Zn	Pb	Cu		
1	Bulk Cleaner conc	9.14	49.08	8.72	0.94				62.7	27.4	30.4		
2	Bulk cleaner tail 3	1.79	27.55	11.92	1.28				6.9	7.3	8.1		
3	" " " 2	2.52	21.20	10.64	1.00				7.5	9.2	8.9		
4	" " " 1	7.95	11.71	7.41	0.50				13.0	20.2	14.1		
5	Bulk Scav conc	3.37	5.34	5.75	0.55				2.5	6.7	6.5		
	Final tail	75.23	0.70	1.13	0.12				7.4	29.2	32.0		
	Feed (calcd)	100.00	7.15	2.91	0.28				100.0	100.0	100.0		
	Calculated Analyses												
	Producs 1 and 2	10.93	45.55	9.24	1.00				69.6	34.7	38.5		
	" 1 to 3	13.45	40.99	9.51	1.00				77.1	43.9	47.4		
	" 1 to 4	21.40	30.11	8.73	0.81				90.1	64.1	61.5		
	" 1 to 5	24.77	26.74	8.32	0.78				92.6	70.8	68.0		

REMARKS:

APPENDIX B

CIRCULATING LOAD CALCULATIONS

METALLURGICAL BALANCE

Test Run No: 7 | Sample: Caribou | Date: May 27, 1982

CIRCULATING LOAD CALCULATIONS

PRODUCT	WT Units	WT %	ANALYSIS %			UNITS			DISTRIBUTION %		
			Zn	Pb	Cu	Zn	Pb	Cu	Zn	Pb	Cu
OVERALL											
Bulk cleaner conc	17.90	17.90	34.57	9.24	0.95	618.8	165.4	17.0	85.6	58.8	54.8
Final tail	82.10	82.10	1.27	1.41	0.17	104.3	115.8	14.0	14.4	41.2	45.2
Feed (calcd)	100.00	100.00	7.23	2.81	0.31	723.1	281.2	31.0	100.0	100.0	100.0
CLEANER											
Bulk cleaner conc	17.90	49.22	34.57	9.24	0.95	618.8	165.4	17.0	61.3	52.5	52.8
Bulk cleaner tail	18.47	50.78	21.16	8.09	0.82	390.8	149.4	15.2	38.7	47.5	47.2
Feed (calcd)	36.37	100.00	27.76	8.66	0.88	1009.6	314.8	32.2	100.0	100.0	100.0
SCAVENGER											
Scav conc	25.84	23.94	13.30	7.76	0.87	343.7	200.5	22.5	76.7	63.4	61.7
Final tail	82.10	76.06	1.27	1.41	0.17	104.3	115.8	14.0	23.3	36.6	38.3
Feed (calcd)	107.94	100.00	4.15	2.93	0.34	448.0	316.3	36.5	100.0	100.0	100.0
CIRCULATING LOAD (CL)											
Bulk cleaner tail	18.47		21.16	8.09	0.82	390.8	149.4	15.2			
Scav conc	25.84		13.30	7.76	0.87	343.7	200.5	22.5			
Total	44.31		16.58	7.90	0.85	734.5	349.9	37.7			
Flotation feed	100.00		7.23	2.81	0.31	723.1	281.2	31.0			
Flotation feed + CL	144.31		10.10	4.37	0.48	1457.6	631.1	68.7			
Increase in feed due to CL	1.44x					2.02 x	2.24 x	2.22 x			

REMARKS: Analyses by XRF.
Zn, Pb and Cu units = Wt units x analysis

METALLURGICAL BALANCE

Test Run No: 8 | **Sample:** Caribou | **Date:** May 31, 1982

CIRCULATING LOAD CALCULATIONS

PRODUCT	WT Units	WT %	ANALYSIS %			UNITS			DISTRIBUTION %		
			Zn	Pb	Cu	Zn	Pb	Cu	Zn	Pb	Cu
OVERALL											
Bulk cleaner conc	20.99	20.99	30.78	8.91	0.81	646.1	187.0	17.0	91.5	64.2	55.9
Final tail	79.01	79.01	0.76	1.32	0.17	60.1	104.3	13.4	8.5	35.8	44.1
Feed (calcd)	100.00	100.00	7.06	2.91	0.30	706.2	291.3	30.4	100.0	100.0	100.0
CLEANER											
Bulk cleaner conc	20.99	36.47	30.78	8.91	0.81	646.1	187.0	17.0	47.9	40.6	41.0
Bulk cleaner tail	36.56	63.53	19.21	7.48	0.67	702.3	273.5	24.5	52.1	59.4	59.0
Feed (calcd)	57.55	100.00	23.43	8.00	0.72	1348.4	460.5	41.5	100.0	100.0	100.0
SCAVENGER											
Scav conc	17.62	18.23	11.29	7.01	0.65	198.9	123.5	11.5	76.8	54.2	46.0
Final tail	79.01	81.77	0.76	1.32	0.17	60.1	104.3	13.4	23.2	45.8	54.0
Feed (calcd)	96.63	100.00	2.68	2.36	0.26	259.0	227.8	24.9	100.0	100.0	100.0
CIRCULATING LOAD (CL)											
Bulk cleaner tail	36.56		19.21	7.48	0.67	702.3	273.5	24.5			
Scav conc	17.62		11.29	7.01	0.65	198.9	123.5	11.5			
Total	54.18		16.63	7.33	0.66	901.2	397.0	36.0			
Flotation feed	100.00		7.06	2.91	0.30	706.2	291.3	30.4			
Flotation feed + CL	154.18		10.43	4.46	0.43	1607.4	688.3	66.4			
Increase in feed due to CL	1.54 x					2.28 x	2.36 x	2.18 x			

REMARKS: Analyses by XRF.
Zn, Pb and Cu units = Wt units x analysis

METALLURGICAL BALANCE

Test Run No: 11-1 | Sample: Caribou | Date: June 8, 1982

CIRCULATING LOAD CALCULATIONS

PRODUCT	WT Units	WT %	ANALYSIS %			UNITS			DISTRIBUTION %		
			Zn	Pb	Cu	Zn	Pb	Cu	Zn	Pb	Cu
OVERALL											
Bulk cleaner conc	20.28	20.28	33.81	9.09	0.91	685.7	184.4	18.5	90.8	62.5	56.3
Final tail	79.72	79.72	0.87	1.39	0.18	69.4	110.8	14.3	9.2	37.5	43.7
Feed (calcd)	100.00	100.00	7.55	2.95	0.33	755.1	295.2	32.8	100.0	100.0	100.0
CLEANER											
Bulk cleaner conc	20.28	46.44	33.81	9.09	0.91	685.7	184.4	18.5	58.6	49.7	53.0
Bulk cleaner tail	23.39	53.56	20.74	7.99	0.70	485.1	186.9	16.4	41.4	50.3	47.0
Feed (calcd)	43.67	100.00	26.81	8.50	0.80	1170.8	371.3	34.9	100.0	100.0	100.0
SCAVENGER											
Scav conc	22.35	21.90	13.93	7.95	0.73	311.3	177.7	16.3	81.8	61.6	53.2
Final tail	79.22	78.10	0.87	1.39	0.18	69.4	110.8	14.3	18.2	38.4	46.8
Feed (calcd)	102.07	100.00	3.73	2.83	0.30	380.7	288.5	30.6	100.0	100.0	100.0
CIRCULATING LOAD (CL)											
Bulk cleaner tail	23.39		20.74	7.99	0.70	485.1	186.9	16.4			
Scav conc	22.35		13.93	7.95	0.73	311.3	177.7	16.3			
Total	45.74		17.41	7.97	0.71	796.4	364.6	32.7			
Flotation feed	100.00		7.55	2.95	0.33	755.1	295.2	32.8			
Flotation feed + CL	145.74		10.65	4.53	0.45	1551.5	659.8	65.5			
Increase in feed due to CL	1.46 x					2.05 x	2.24 x	2.00 x			

REMARKS: Analyses by XRF.
Zn, Pb and Cu units = Wt units x analysis

METALLURGICAL BALANCE

Test Run No: 11-2 | Sample: Caribou | Date: June 8, 1982

CIRCULATING LOAD CALCULATIONS

PRODUCT	WT. Units	WT %	ANALYSIS %			UNITS			DISTRIBUTION %		
			Zn	Pb	Cu	Zn	Pb	Cu	Zn	Pb	Cu
OVERALL											
Bulk cleaner conc	20.78	20.78	31.61	8.05	0.72	656.9	167.3	15.0	92.5	59.6	51.2
Final tail	79.22	79.22	0.67	1.43	0.18	53.1	113.3	14.3	7.5	40.4	48.8
Feed (calcd)	100.00	100.00	7.10	2.81	0.29	710.0	280.6	29.3	100.0	100.0	100.0
CLEANER											
Bulk cleaner conc	20.78	29.52	31.61	8.05	0.72	656.9	167.3	15.0	38.4	30.3	32.1
Bulk cleaner tail	49.61	70.48	21.21	7.77	0.64	1052.2	385.5	31.8	61.6	69.7	67.9
Feed (calcd)	70.39	100.00	24.28	7.85	0.66	1709.1	552.8	46.8	100.0	100.0	100.0
SCAVENGER											
Scav conc	48.20	37.83	11.93	6.85	0.71	575.0	330.2	34.2	91.5	74.5	70.5
Final tail	79.22	61.17	0.67	1.43	0.18	53.1	113.3	14.3	8.5	25.5	29.5
Feed (calcd)	127.42	100.00	4.93	3.48	0.38	628.1	443.5	48.5	100.00	100.0	100.0
CIRCULATING LOAD (CL)											
Bulk cleaner tail	49.61		21.21	7.77	0.64	1052.2	385.5	31.8			
Scav conc	48.20		11.93	6.85	0.71	575.0	330.2	34.2			
Total	97.81		16.64	7.32	0.67	1627.2	715.7	66.0			
Flotation feed	100.00		7.10	2.81	0.29	710.0	280.6	29.3			
Flotation feed + CL	197.81		11.82	5.04	0.48	2337.2	996.3	95.3			
Increase in feed due to CL	1.98 x					3.29 x	3.55 x	3.25 x			

REMARKS: Analyses by XRF.
Zn, Pb and Cu units = Wt units x analysis

METALLURGICAL BALANCE

Test Run No: 12-1	Sample: Caribou	Date: June 10, 1982

CIRCULATING LOAD CALCULATIONS

PRODUCT	WT Units	WT %	ANALYSIS %			UNITS			DISTRIBUTION %		
			Zn	Pb	Cu	Zn	Pb	Cu	Zn	Pb	Cu
OVERALL											
Bulk cleaner conc	25.02	25.02	25.63	7.72	0.84	641.3	193.2	21.0	92.3	69.5	65.1
Final tail	74.98	74.98	0.71	1.13	0.15	53.2	84.7	11.3	7.7	30.5	34.9
Feed (calcd)	100.00	100.00	6.95	2.78	0.32	694.5	277.9	32.3	100.0	100.0	100.0
CLEANER											
Bulk cleaner conc	25.02	71.17	25.63	7.72	0.84	641.3	193.2	21.0	77.0	74.1	77.2
Bulk cleaner tail	10.14	28.83	18.90	6.66	0.61	191.7	67.5	6.2	23.0	25.9	22.8
Feed (calcd)	35.16	100.00	23.69	7.41	0.77	833.0	260.7	27.2	100.0	100.0	100.0
SCAVENGER											
Scav conc	50.05	40.03	8.23	5.23	0.51	411.9	261.8	25.5	88.6	75.6	69.3
Final tail	74.98	59.97	0.71	1.13	0.15	53.2	84.7	11.3	11.4	24.4	30.7
Feed (calcd)	125.03	100.00	3.72	2.77	0.29	465.1	346.5	36.8	100.0	100.0	100.0
CIRCULATING LOAD (CL)											
Bulk cleaner tail	10.14		18.90	6.66	0.61	191.7	67.5	6.2			
Scav conc	50.05		8.23	5.23	0.51	411.9	261.8	25.5			
Total	60.19		10.03	5.47	0.53	603.6	329.3	31.7			
Flotation feed	100.00		6.95	2.78	0.32	694.5	277.9	32.3			
Flotation feed + CL	160.19		8.10	3.79	0.40	1298.1	607.2	64.0			
Increase in feed due to CL	1.60 x					1.87 x	2.18 x	1.98 x			

REMARKS: Analyses by XRF.
Zn, Pb and Cu units = Wt units x analysis

METALLURGICAL BALANCE

Test Run No: 12-2	Sample: Caribou	Date: June 10, 1982

CIRCULATING LOAD CALCULATIONS

PRODUCT	WT Units	WT %	ANALYSIS %			UNITS			DISTRIBUTION %		
			Zn	Pb	Cu	Zn	Pb	Cu	Zn	Pb	Cu
OVERALL											
Bulk cleaner conc	22.02	22.02	29.62	8.02	0.79	652.2	176.6	17.4	89.2	61.3	55.3
Final tail	77.98	77.98	1.01	1.43	0.18	78.8	111.5	14.0	10.8	38.7	44.7
Feed (calcd)	100.00	100.00	7.31	2.88	0.31	731.0	288.1	31.4	100.0	100.0	100.0
CLEANER											
Bulk cleaner conc	22.02	45.66	29.62	8.02	0.79	652.2	176.6	17.4	56.1	49.4	52.6
Bulk cleaner tail	26.21	54.34	19.48	6.90	0.60	510.6	180.9	15.7	43.9	50.6	47.4
Feed (calcd)	48.23	100.00	24.11	7.41	0.69	1162.8	375.5	33.1	100.0	100.0	100.0
SCAVENGER											
Scav conc	32.76	29.58	10.61	5.95	0.51	347.6	194.9	16.7	81.5	63.6	54.4
Final tail	77.98	70.42	1.01	1.43	0.18	78.8	111.5	14.0	18.5	36.4	45.6
Feed (calcd)	110.74	100.00	3.85	2.77	0.28	426.4	306.4	30.7	100.0	100.0	100.0
CIRCULATING LOAD (CL)											
Bulk cleaner tail	26.21		19.48	6.90	0.60	510.6	180.9	15.7			
Scav conc	32.76		10.61	5.95	0.51	347.6	194.9	16.7			
Total	58.97		14.55	6.37	0.55	858.2	375.8	32.4			
Flotation feed	100.00		7.31	2.88	0.31	731.0	288.1	31.4			
Flotation feed + CL	158.98		10.00	4.18	0.40	1589.2	663.9	63.8			
Increase in feed due to CL	1.59 x					2.17 x	2.30 x	2.03 x			

REMARKS: Analyses by XRF.
Zn, Pb and Cu units = Wt units x analysis

METALLURGICAL BALANCE

Test Run No: 13-1 | Sample: Caribou | Date: June 15, 1982

CIRCULATING LOAD CALCULATIONS

PRODUCT	WT Units	WT %	ANALYSIS %			UNITS			DISTRIBUTION %		
			Zn	Pb	Cu	Zn	Pb	Cu	Zn	Pb	Cu
OVERALL											
Bulk cleaner conc	29.40	29.40	21.85	6.72	0.73	642.4	197.6	21.5	94.9	72.9	64.2
Final tail	70.60	70.60	0.49	1.04	0.17	34.6	73.4	12.0	5.1	27.1	35.8
Feed (calcd)	100.00	100.00	6.77	2.71	0.33	677.0	271.0	33.5	100.0	100.0	100.0
CLEANER											
Bulk cleaner conc	29.40	77.51	21.85	6.72	0.73	642.4	197.6	21.5	84.4	78.8	75.4
Bulk cleaner tail	8.53	22.49	13.89	6.22	0.82	118.5	53.1	7.0	15.6	21.2	24.6
Feed (calcd)	37.93	100.00	20.06	6.61	0.75	760.9	250.7	28.5	100.0	100.0	100.0
SCAVENGER											
Scav conc	21.57	23.40	4.08	4.79	0.55	88.0	103.3	11.9	71.8	58.5	49.8
Final tail	70.60	76.60	0.49	1.04	0.17	34.6	73.4	12.0	28.2	41.5	50.2
Feed (calcd)	92.17	100.00	1.33	1.92	0.26	122.6	176.7	23.9	100.0	100.0	100.0
CIRCULATING LOAD (CL)											
Bulk cleaner tail	8.53		13.89	6.22	0.82	118.5	53.1	7.0			
Scav conc	21.57		4.08	4.79	0.55	88.0	103.3	11.9			
Total	30.10		6.86	5.20	0.63	206.5	156.4	18.9			
Flotation feed	100.00		6.77	2.71	0.33	677.0	271.0	33.5			
Flotation feed + CL	130.10		6.79	3.29	0.40	883.5	427.4	52.4			
Increase in feed due to CL	1.30 x					1.31 x	1.58 x	1.56 x			

REMARKS: Analyses by XRF.
Zn, Pb and Cu units = Wt units x analysis

METALLURGICAL BALANCE

Test Run No: 13-2 | **Sample:** Caribou | **Date:** June 15, 1982

CIRCULATING LOAD CALCULATIONS

PRODUCT	WT Units	WT %	ANALYSIS %			UNITS			DISTRIBUTION %		
			Zn	Pb	Cu	Zn	Pb	Cu	Zn	Pb	Cu
OVERALL											
Bulk cleaner conc	27.53	27.53	25.01	7.74	0.67	688.5	213.1	18.5	94.1	71.7	61.4
Final tail	72.47	72.47	0.60	1.16	0.16	43.5	84.1	11.6	5.9	28.3	38.6
Feed (calcd)	100.00	100.00	7.32	2.97	0.30	732.0	297.2	30.1	100.0	100.0	100.0
CLEANER											
Bulk cleaner conc	27.53	59.91	25.01	7.74	0.67	688.5	213.1	18.5	72.7	64.7	57.5
Bulk cleaner tail	18.42	40.09	14.01	6.30	0.74	258.1	116.1	13.6	27.3	35.3	42.5
Feed (calcd)	45.95	100.00	20.60	7.16	0.70	946.6	329.2	32.1	100.0	100.0	100.0
SCAVENGER											
Scav conc	24.16	25.00	4.56	4.69	0.54	110.2	113.3	13.1	71.7	57.4	53.0
Final tail	72.47	75.00	0.60	1.16	0.16	43.5	84.1	11.6	28.3	42.6	47.0
Feed (calcd)	96.63	100.00	1.59	2.04	0.26	153.7	197.4	24.7	100.0	100.0	100.0
CIRCULATING LOAD (CL)											
Bulk cleaner tail	18.42		14.01	6.30	0.74	258.1	116.1	13.6			
Scav conc	24.16		4.56	4.69	0.54	110.2	113.3	13.1			
Total	42.58		8.65	5.39	0.63	368.3	229.4	26.7			
Flotation feed	100.00		7.32	2.97	0.30	732.0	297.2	30.1			
Flotation feed + CL	142.58		7.72	3.69	0.40	1100.3	526.6	56.8			
Increase in feed due to CL	1.43 x					1.50 x	1.77 x	1.89 x			

REMARKS: Analyses by XRF.
Zn, Pb and Cu units = Wt units x analysis

METALLURGICAL BALANCE

Test Run No: 15 - 1 | Sample: Caribou | Date: June 22, 1982

CIRCULATING LOAD CALCULATIONS

PRODUCT	WT Units	WT %	ANALYSIS %			UNITS			DISTRIBUTION %		
			Zn	Pb	Cu	Zn	Pb	Cu	Zn	Pb	Cu
OVERALL											
Bulk cleaner conc	22.40	22.40	28.06	8.87	0.91	628.5	198.7	20.4	86.8	65.5	56.8
Final tail	77.60	77.60	1.23	1.35	0.20	95.5	104.8	15.5	13.2	34.5	43.2
Feed (calcd)	100.00	100.00	7.24	3.04	0.36	724.0	303.5	35.9	100.0	100.0	100.0
CLEANER											
Bulk cleaner conc	22.40	38.18	28.06	8.87	0.91	628.5	198.7	20.4	47.9	47.6	46.8
Bulk cleaner tail	36.27	61.82	18.84	6.04	0.64	683.3	219.1	23.2	52.1	52.4	53.2
Feed (calcd)	58.67	100.00	22.36	7.12	0.74	1311.8	417.8	43.6	100.0	100.0	100.0
SCAVENGER											
Scav conc	23.45	23.21	11.87	5.18	0.63	278.4	121.5	14.8	74.5	53.7	48.8
Final tail	77.60	76.79	1.23	1.35	0.20	95.5	104.8	15.5	25.5	46.3	51.2
Feed (calcd)	101.05	100.00	3.70	2.24	0.30	373.9	226.3	30.3	100.0	100.0	100.0
CIRCULATING LOAD (CL)											
Bulk cleaner tail	36.27		18.84	6.04	0.64	683.3	219.1	23.2			
Scav conc	23.45		11.87	5.18	0.63	278.4	121.5	14.8			
Total	59.72		16.10	5.70	0.64	961.7	340.6	38.0			
Flotation feed	100.00		7.24	3.04	0.36	724.0	303.5	35.9			
Flotation feed + CL	159.72		10.55	4.03	0.46	1685.7	644.1	73.9			
Increase in feed due to CL	1.60 x					2.33 x	2.12 x	2.06 x			

REMARKS: Analyses by XRF.
Zn, Pb and Cu units = Wt units x analysis

METALLURGICAL BALANCE

Test Run No: 15 - 2 | **Sample:** Caribou | **Date:** June 22, 1982

CIRCULATING LOAD CALCULATIONS

PRODUCT	WT Units	WT %	ANALYSIS %			UNITS			DISTRIBUTION %		
			Zn	Pb	Cu	Zn	Pb	Cu	Zn	Pb	Cu
OVERALL											
Bulk cleaner conc	23.05	23.05	30.77	8.77	1.08	709.3	202.2	24.9	92.4	69.6	69.8
Final tail	76.95	76.95	0.76	1.15	0.14	58.5	88.5	10.8	7.6	30.4	30.2
Feed (calcd)	100.00	100.00	7.68	2.91	0.36	767.8	290.7	35.7	100.0	100.0	100.0
CLEANER											
Bulk cleaner conc	23.05	33.97	30.77	8.77	1.08	709.3	202.2	24.9	46.5	39.6	43.9
Bulk cleaner tail	44.80	66.03	18.20	6.89	0.71	815.3	308.7	31.8	53.5	60.4	56.1
Feed (calcd)	67.85	100.00	22.47	7.53	0.84	1524.6	510.9	56.7	100.0	100.0	100.0
SCAVENGER											
Scav conc	20.59	21.11	7.44	5.60	0.62	153.2	115.3	12.8	72.4	56.6	54.2
Final tail	76.95	78.89	0.76	1.15	0.14	58.5	88.5	10.8	27.6	43.4	45.8
Feed (calcd)	97.54	100.00	2.17	2.09	0.24	211.7	203.8	23.6	100.0	100.0	100.0
CIRCULATING LOAD (CL)											
Bulk cleaner tail	44.80		18.20	6.89	0.71	815.3	308.7	31.8	84.2	72.8	71.3
Scav conc	20.59		7.44	5.60	0.62	153.2	115.3	12.8	15.8	27.2	28.7
Total	65.39		14.81	6.48	0.68	968.5	424.0	44.6	100.0	100.0	100.0
Flotation feed	100.00		7.68	2.91	0.36	767.8	290.7	35.7			
Flotation feed + CL	165.39		10.50	4.32	0.49	1736.3	714.7	80.3			
Increase in feed due to CL	1.65 x					2.26 x	2.46 x	2.25 x			

REMARKS: Analyses by XRF.
Zn, Pb and Cu units = Wt units x analysis

METALLURGICAL BALANCE

Test Run No: 16 - 1 | Sample: Caribou | Date: June 23, 1982

CIRCULATING LOAD CALCULATIONS

PRODUCT	WT Units	WT %	ANALYSIS %			UNITS			DISTRIBUTION %		
			Zn	Pb	Cu	Zn	Pb	Cu	Zn	Pb	Cu
OVERALL											
Bulk cleaner conc	21.82	21.82	29.80	9.01	0.83	649.6	196.4	18.1	89.1	66.2	56.2
Final tail	78.28	78.28	1.02	1.28	0.18	79.8	100.1	14.1	10.9	33.8	43.8
Feed (calcd)	100.00	100.00	7.29	2.97	0.32	729.4	296.5	32.2	100.0	100.0	100.0
CLEANER											
Bulk cleaner conc	21.82	37.75	29.80	9.01	0.83	649.6	196.4	18.1	46.0	44.2	39.2
Bulk cleaner tail	35.98	62.25	21.19	6.88	0.78	762.4	247.5	28.1	54.0	55.8	60.8
Feed (calcd)	57.80	100.00	24.44	7.68	0.80	1412.0	443.9	46.2	100.0	100.0	100.0
SCAVENGER											
Scav conc	18.48	19.10	12.17	5.94	0.72	224.9	109.8	13.3	73.8	52.3	48.5
Final tail	78.28	80.90	1.02	1.28	0.18	79.8	100.1	14.1	26.2	47.7	51.5
Feed (calcd)	96.76	100.00	3.15	2.17	0.28	304.7	209.9	27.4	100.0	100.0	100.0
CIRCULATING LOAD (CL)											
Bulk cleaner tail	35.98		21.19	6.88	0.78	762.4	247.5	28.1			
Scav conc	18.48		12.17	5.94	0.72	224.9	109.8	13.3			
Total	54.46		18.13	6.56	0.76	987.3	357.3	41.4			
Flotation feed	100.00		7.29	2.97	0.32	729.4	296.5	32.2			
Flotation feed + CL	154.46		11.11	4.23	0.48	1716.7	653.8	73.6			
Increase in feed due to CL	1.54 x					2.35 x	2.21 x	2.29 x			

REMARKS: Analyses by XRF.
Zn, Pb and Cu units = Wt units x analysis

METALLURGICAL BALANCE

Test Run No: 16 - 2	Sample: Caribou	Date: June 23, 1982

CIRCULATING LOAD CALCULATIONS

PRODUCT	WT Units	WT %	ANALYSIS %			UNITS			DISTRIBUTION %		
			Zn	Pb	Cu	Zn	Pb	Cu	Zn	Pb	Cu
OVERALL											
Bulk cleaner conc	21.59	21.59	32.10	9.57	0.97	693.0	206.6	20.9	89.7	69.1	59.7
Final tail	78.41	78.41	1.02	1.18	0.18	80.0	92.5	14.1	10.3	30.9	40.3
Feed (calcd)	100.00	100.00	7.73	2.99	0.35	773.0	299.1	35.0	100.0	100.0	100.0
CLEANER											
Bulk cleaner conc	21.59	45.82	32.10	9.57	0.97	693.0	206.6	20.9	56.0	52.9	49.7
Bulk cleaner tail	25.53	54.18	21.34	7.21	0.83	544.8	184.1	21.2	44.0	47.1	50.3
Feed (calcd)	47.12	100.00	26.27	8.29	0.89	1237.8	390.7	42.1	100.0	100.0	100.0
SCAVENGER											
Scav conc	13.24	14.45	11.26	6.91	0.76	149.1	91.5	10.1	65.1	41.7	
Final tail	78.41	85.55	1.02	1.18	0.18	80.0	92.5	14.1	34.9	58.3	
Feed (calcd)	91.65	100.00	2.50	2.01	0.26	229.1	184.0	24.2	100.0	100.0	
CIRCULATING LOAD (CL)											
Bulk cleaner tail	25.53		21.34	7.21	0.83	544.8	184.1	21.2			
Scav conc	13.24		11.26	6.91	0.76	149.1	91.5	10.1			
Total	38.77		17.90	7.11	0.81	693.9	275.6	31.3			
Flotation feed	100.00		7.73	2.99	0.35	773.0	299.1	35.0			
Flotation feed + CL	138.77		10.57	4.14	0.48	1466.9	574.7	66.3			
Increase in feed due to CL											
	1.39 x					1.90 x	1.92 x	1.89 x			

REMARKS: Analyses by XRF.
Zn, Pb and Cu units = Wt units x analysis

METALLURGICAL BALANCE

Test Run No: 17 - 1 | Sample: Caribou | Date: June 24, 1982

CIRCULATING LOAD CALCULATIONS

PRODUCT	WT Units	WT %	ANALYSIS %			UNITS			DISTRIBUTION %		
			Zn	Pb	Cu	Zn	Pb	Cu	Zn	Pb	Cu
OVERALL											
Bulk cleaner conc	23.39	23.39	28.29	7.99	0.96	662.0	187.0	22.5	93.2	67.2	64.7
Final tail	76.61	76.61	0.63	1.19	0.16	48.3	91.2	12.3	6.8	32.8	35.3
Feed (calcd)	100.00	100.00	7.10	2.78	0.35	710.3	278.2	34.8	100.0	100.0	100.0
CLEANER											
Bulk cleaner conc	23.39	31.75	28.29	7.99	0.96	662.0	187.0	22.5	43.1	35.7	38.7
Bulk cleaner tail	50.28	68.35	17.36	6.71	0.71	872.9	337.4	35.7	56.9	64.3	61.3
Feed (calcd)	73.67	100.00	20.83	7.12	0.79	1534.9	524.4	58.2	100.0	100.0	100.0
SCAVENGER											
Scav conc	43.98	36.47	4.88	4.67	0.51	214.6	205.4	22.4	81.6	69.3	64.6
Final tail	76.61	63.53	0.63	1.19	0.16	48.3	91.2	12.3	18.4	30.7	35.4
Feed (calcd)	120.59	100.00	2.18	2.46	0.29	262.9	296.6	34.7	100.0	100.0	100.0
CIRCULATING LOAD (CL)											
Bulk cleaner tail	50.28		17.36	6.71	0.71	822.9	337.4	35.7			
Scav conc	43.98		4.88	4.67	0.51	214.6	205.4	22.4			
Total	94.26		11.54	5.76	0.62	1087.5	542.8	58.1			
Flotation feed	100.00		7.10	2.78	0.35	710.3	278.2	34.8			
Flotation feed + CL	194.26		9.25	4.23	0.48	1797.8	821.0	92.9			
Increase in feed due to CL	1.94 x					2.53 x	2.95 x	2.67 x			

REMARKS: Analyses by XRF.
Zn, Pb and Cu units = Wt units x analysis